Reports

Early Flakes from Sozudai, Japan: Are They Man-Made?

Abstract. *Some archeologists consider the lowest component of the Sozudai site to be evidence of a human occupation of southern Japan during the early Würm period. Others deny that the Sozudai objects are artifacts. With separate test procedures, flakes in the Sozudai assemblage were identified and compared to the standard developed by A. S. Barnes. These procedures indicate that flakes in the Sozudai assemblage are of human origin.*

The major controversy in Japanese Paleolithic archeology today centers around the identification of the oldest cultural remains in the Japanese Islands (*1*). It is now almost universally agreed that Japan was occupied during the later part of the last glacial period by cultures generally similar to other Eurasian Upper Paleolithic groups. Some archeologists believe that the remains of these Upper Paleolithic groups are the oldest so far found in the islands and that their creators probably arrived to find an uninhabited area in what is today Japan (*2*). However, a number of prominent archeologists are convinced that they have found sites and stone artifacts of earlier cultures. These earlier assemblages are assigned to the mid-to-early Late Pleistocene and might be generally aligned with the East Asian Chopper–Chopping Tool Tradition or with the "Early Paleolithic" (*3*). To those that favor the later arrival of human groups, all of the proposed earlier sites are suspect. The geological context of some finds is suspect, but more often the detractors simply do not believe that the crude objects said to represent the earlier cultural remains are man-made (*4*). Several typological discussions of the early materials have been presented (*5*), but until now identification or rejection of the early stone tools has been based on intuitive and subjective judgments. I present here an objective appraisal of one well-known early assemblage from the site of Sozudai in northeastern Kyushu.

Recently archeologists and physicists have begun to investigate the physical basis of flaked stone objects (*6*). Hopefully this research will eventually yield a theoretically based method for differentiating between naturally and artificially flaked stone objects. Such a method is not yet available. The most satisfactory means of making the differentiation between artificial and natural flaked stones remains the empirically based procedure developed in the late 1930's by Barnes (*7*). Barnes observed that assemblages of artificially flaked stones could be differentiated from groups of naturally chipped stones on the basis of the core angle between the surface struck and the scar left by the flake that was removed (Fig. 1). He found that in artifact assemblages this angle was acute in at least 75 percent of the cases, but that among naturally fractured stone 40 percent or more of these angles were obtuse. More recently Ascher and Ascher (*8*) pointed out that Barnes's method can be validly applied only if collecting and sampling procedures do not interject a bias into the measured population.

Sozudai is a multicomponent archeological site located on the 35-m terrace of Beppu Bay in northeastern Kyushu. It has been tested several times. The sample that I discuss here was recovered from a trench 3 by 4 m (designated trench P) excavated in 1964 by C. Serizawa and a field party from Tohoku University. Stones, which Serizawa believes are artifacts, are attributed by him to the early phases of the last glacial period. They were found in and near a buried gravel layer which was below and unquestionably isolated from overlying Jomon and late Paleolithic cultural horizons. The terrace on which the site is located was apparently formed during the Shimosueyoshi Transgression, which occurred during the Riss/Würm Interglacial. This information establishes a maximum age for the site. Ikawa-Smith (9) has noted that there is no geological or chronometric means of assigning a specific minimum age to the lower Sozudai component. On the basis of archeological stratigraphy, however, the investigators of the site believe that the lowest component should be assigned to the early portion of the Würm glaciation (10).

The gravel layer at the base of the Sozudai site contained two major stone categories. Most of this layer was composed of soft pieces of chalky andesite. Since this stone was highly weathered and extremely soft, none of it could be found to show traces of potential human alteration. It also seems highly unlikely that natural rolling of this soft material could have broken or flaked the hard stones also contained in the gravel layer. Serizawa identified artifacts only among the harder stone category, which was composed of pieces of quartz rhyolite and vein quartz. This stone is coarse-grained and rife with flaws and impurities and, although much harder than the andesite, it too is heavily weathered. Flake scars and other possible signs of human alteration were thus hard to identify. For this reason, the harder rocks were not field-sorted. Every piece of the harder stone found in trench P was returned to Tohoku University for analysis. The 12-m^2 trench yielded in all 433 pieces of quartz rhyolite and vein quartz. Although Serizawa (11) has presented a detailed descriptive analysis of the Sozudai assemblage, some archeologists continue to question its human origin.

The coarse, heavily weathered surfaces of the Sozudai stones make it difficult to recognize even such basic attributes as flake scars and marginal retouch. Thus, after a brief examination of the entire assemblage, I decided to apply Barnes's procedures to all of the flakes found in trench P. The angle between the striking platform and the ventral surface of a flake is the mathematical supplement of the core angles Barnes dealt with; thus data from flakes are amenable to his procedures (Fig. 1). Recognition of flakes also proved far easier than the positive identification of flake scars. The landmarks of true flakes were more easily identified than their mirrored counterparts on flaked surfaces. Furthermore, although the angular surfaces of the Sozudai rocks contained a great number of apparent flaked scars, the number of objectively identifiable flakes was much smaller. The entire flake population could be treated, thus obviating the need to sample the collection.

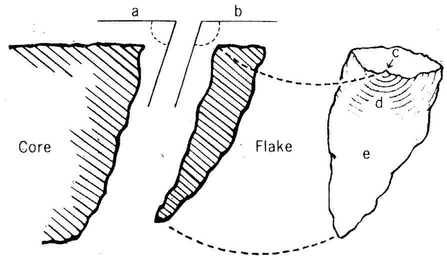

Fig. 1. Schematic diagram showing (a) the core angle used by Barnes, (b) the supplementary flake angle used in this research, (c) the point of percussion, (d) the bulb of percussion, and (e) the ventral surface of the flake.

In order to obtain insights into the technical properties and characteristics of quartz rhyolite and vein quartz found at Sozudai, I struck several hundred flakes from geologically similar stone from the Akiu region of the Miyagi prefecture. These simulations made several characteristics of the raw materials clear. A large number of nodules, probably a majority, could not be flaked. A blow to such nodules would detach only irregular jagged nonflake fragments. Other nodules were more homogeneous and readily yielded true flakes. Even among these nodules, however, many flake fractures were distorted by inconsistencies in the raw material. Experiments also showed that antler and even wood percussors could detach flakes from better-quality nodules. Even flakes struck with hammerstones and pointed steel hammers, however, showed markedly diffuse or flat bulbs of percussion, which

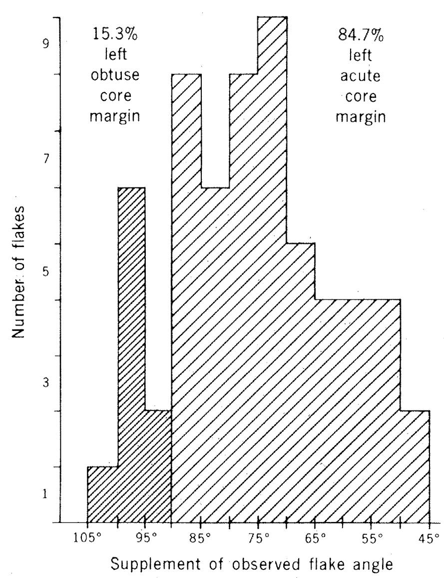

Fig. 2. Distribution of flake angle sizes in the Sozudai flakes. Heavy shading represents flakes detached from obtuse core margins (15.3 percent). Light shading represents flakes detached from acute core margins (84.7 percent).

Kobayashi (12) has noted as a characteristic of other early Japanese stone tool assemblages.

With insights gained from these simulations, I attempted to isolate all of the flakes from the trench P collection. Any piece which retained an identifiable striking platform and a bulb of percussion was considered a flake. Because of the coarseness of the raw material and the heavily weathered surfaces of the individual pieces, even identification of these attributes proved at times difficult and subjective. Thus, a procedure was established for identification of problematical flakes and a separate test was designed to test the validity of the finally determined flake sample.

Problematical pieces were separately shown to three other archeologists who were familiar with the Sozudai material and flake characteristics. If the same striking point was not identified by all four observers, the piece was not considered a flake and it was excluded from further consideration. This procedure yielded a total of 59 flakes for which familiar observers could readily and consistently identify such landmarks as striking platform, point of percussion, and dorsal and ventral surfaces. This number constitutes 13.6 percent of the total assemblage excavated from trench P.

Since each flake could yield only one angle measurement, the sample is somewhat smaller than the 100 measurements which Barnes suggested was adequate to characterize an assemblage. I judged the sample of 59 measurements adequate, however, because it was reasonably large and because it included all of the identifiable flakes from one arbitrarily selected portion of the Sozudai site.

Figure 2 shows the distribution of flake angle sizes of the Sozudai flakes. To make these data comparable to Barnes's observations, the mathematical supplement of the flake angle is recorded. Some 85 percent of the Sozudai flakes left acute core edges after they were detached. This distribution of flake angles is well within the range Barnes found to be characteristic of artificially flaked assemblages. It indicates that prehistoric humans did, indeed, work at least some of the rocks contained in the lowest level of the Sozudai.

Since identification of at least some of the Sozudai flakes entailed difficult personal judgments, a separate test was undertaken to validate and verify the sample of flakes which was finally isolated. For this purpose, I formed a test sample consisting of five randomly selected Sozudai flakes, a group of five nonflake pebbles, and eight new flakes produced during my simulations. The pebbles and new flakes were lithologically similar to the Sozudai material. The new flakes were also stained to make them appear similar to the weathered Sozudai flakes.

The test sample of 18 pieces was shown separately to a total of 27 (11 Japanese and 16 American) archeologists who claimed to be familiar with flake characteristics. The observers were asked to identify the flakes in the test sample. On each piece identified as a flake the observer had to indicate the point of percussion, the bulb of percussion, and the ventral surface. Three of the new flakes served as a control group. If any of these flakes were not accurately described, the observer's opinions on the rest of the samples were disregarded. Only 19 observers correctly identified all of the flakes in the control sample. All of these observers also correctly identified all of the newly made flakes.

All of these 19 archeologists identified at least one of the Sozudai pieces as a flake. Only two of them, however, considered all five of the Sozudai pieces to be flakes. Since each of the 19 observers was presented with five pieces from Sozudai, a total of 95 judgments were elicited. Of these judgments, 61 were in exact agreement with the identifications reached during my own flake identification procedure. Observers were presented with a small, randomly selected sample of heavily weathered Sozudai flakes. Furthermore, these pieces were not presented in the context of a total assemblage and the observers were called on to make their judgments on the basis of only relatively brief examination. It is, therefore, not surprising that their judgments were not in total agreement with mine which were based on long, detailed examination of the entire Sozudai collection. A χ^2 test applied to the results of the observations, however, does indicate a strong positive correlation between my identifications and those of other observers ($\chi^2 = 7.66$, $p < .01$, d.f. = 1). My conclusions on the Sozudai flake sample thus are substantiated by observations of other trained archeologists.

Thus, although some Japanese and American archeologists have questioned the human creation of the Sozudai assemblage, an independently substantiated test procedure indicates that at least 13.6 percent of the assemblage is composed of flakes. Furthermore, when the characteristics of these flakes are compared to the criteria established by A. S. Barnes, the Sozudai assemblage seems to be clearly of human rather than natural origin. Since the Sozudai assemblage clearly predates Upper Paleolithic industries and probably dates from the early phases of the last glacial period, these conclusions strongly support an early human occupation of southern Japan.

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13. I began this research while I was a Japan Foundation Fellow at Tohoku University. I thank Prof. C. Serizawa, who generously made the Sozudai collection available and freely shared his knowledge of Japanese prehistory. I also thank H. Kobayashi and M. Okamura for their help and support. Dr. A. Bleed also gave valuable help with the framing and execution of the research.

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Thermoluminescent Determination of Prehistoric Heat Treatment of Chert Artifacts

Abstract. *In recent years archeologists have become interested in the extent to which prehistoric peoples heat-treated chert prior to shaping it into tools. Thermoluminescent determination of the radiation dose accumulated by an artifact since it was formed or last heated provides a simple, reliable test for such heat treatment. This test can be applied to single artifacts without the need for raw source material for comparison. Results on 25 artifacts from four sites indicate that, for many chert sources, color and luster are not useful indicators of heat treatment by prehistoric peoples.*

Chert is the most common raw material in the lithic technology of prehistoric peoples. Various accounts of the use of heat treatment in the manufacture of tools by primitive peoples have been reported since at least the turn of the century (*1*), but the lack of success in duplicating these techniques led to a general skepticism which prevailed for many years. However, in 1964 Crabtree and Butler (*2*) reported that, when raw chert was slowly heated and slowly cooled in sand, marked improvements in the knapping properties resulted.

In recent years the belief that prehistoric people sometimes heat-treated chert before shaping it into finished tools has gained support and generated interest in finding a simple, reliable test for heat treatment. A number of techniques have been applied in attempts to determine whether particular chert artifacts were heated by prehistoric people. Probably the most common has been an examination of the visual appearance. A pink or reddish color or a vitreous luster, or both, are often taken as evidence of heating. Many forms of chert display these characteristics upon heat treatment (*1, 2*). However, in addition to being a subjective test, these characteristics may also result from nonthermal effects. Raw chert, even within a single outcrop, often varies greatly in color with reds and pinks produced, for example, by exposure to groundwater containing iron; a vitreous luster on a tool may be caused by polishing of the surface from repeated use.

More sophisticated techniques have been used to provide evidence of heat treatment, including electron microscopy and x-ray diffraction. Electron microscopy indicates that high temperatures bring about changes in the microcrystalline quartz structure of chert (*1, 3*). Weymouth and Mandeville (*4*) reported x-ray diffraction line-broadening in some (but not all) heat-treated cherts, presumably due to the breakup of the original crystals into smaller crystals or to local strains. However, both these measurements require raw source material for comparison, and the authors concluded that neither provided a reliable, independent test.

In view of the success of thermoluminescence (TL) dating of archeologic ceramics (*5*), it has been proposed that heat-treated chert could also be dated in